Interim Findings and Preliminary Conclusions: Analysis of GHG Reduction Strategies for the Climate Change Advisory Committee

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Presentation Overview

- Presentation of “big picture” analytical results
- Summary of Broad-based Approaches to Mitigation
- Review of sector analyses conducted to date and potential policy options for each sector
- Update on ongoing power sector and petroleum refining analyses
- Conclusions

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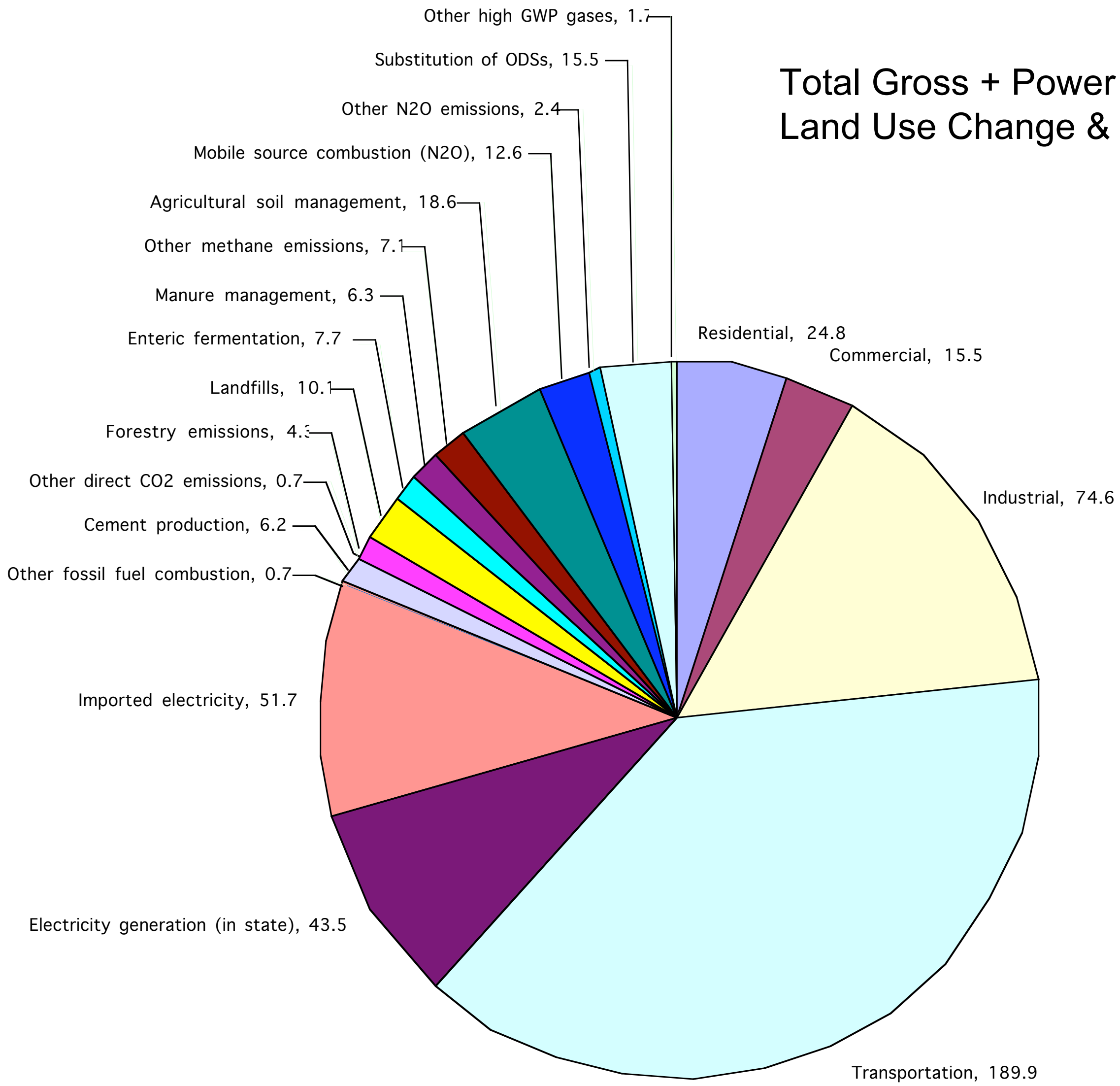
California 2002 GHG Emissions Inventory

Total Gross + Power Imports = 493.9
Land Use Change & Forestry Sinks = -20.3



Overview of Analytical Results To Date (1)

- CCAP evaluated measures in the transportation, cement and sinks (forestry and agriculture) sectors.
- ICF Consulting evaluated measures to reduce high GWP gases in the landfill, natural gas, semiconductor and dairy sectors, among others.
- Measures identified thus far are projected to reduce GHG emissions by 44 $MMTCO_2e$ in 2010 and 117 MMTCO2 in 2020.
- These measures are additional to strategies already underway in California that are estimated to reduce GHGs by 23 $MMTCO_2e$ in 2010 and 70 MMTCO2 in 2020.
- Power sector and refinery options would be expected to increase the total reduction potential by roughly 15* and 2** $MMTCO_2e$ in 2010, respectively, and by 26* and 6** $MMTCO_2e$ in 2020.***

* Power sector reductions assume a cap set 2000 levels after subtracting out reduction that are credited to the accelerated RPS (33% by 2020)..
** Refinery reductions assume stabilization at 2005 levels.
*** Both estimates assume preliminary CCAP baseline projections. Baselines for both sectors will change once plant-specific refining data and the power sector modeling study are available. We do not know how the costs of these reductions compare with options available to other sectors.

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Summary of Emissions Reductions by Sector

Total GHG Reduction Potential (MMTCO2e)

Sector	2010 CCAP/ICF	2020 CCAP/ICF
Transportation	8.3	65.4
Power	TBD	TBD
Agriculture/Forestry	12.5	18.0
Methane	15.6	16.7
PFC	3.1	7.1
HFC	0.9	6.2
Cement	2.2	2.4
SF6	1.2	1.5
Oil Refining	TBD	TBD
ALL	43.8	117.4

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Strategies Already Underway in CA

Lead Agency/Strategy	GHG Savings [1] (Million Tons CO_2 Equivalent) 2010	2020
Air Resources Board		
GHG Vehicle Standards (AB 1493)	1	30
Diesel Anti -idling	1	2
Energy Commission /Public Utilities Commission		
Accelerated Renewable Portfolio Std (33% by 2020)	5	11
Million Solar Roofs	0.4	3
Integrated Waste Management Board		
Zero Waste/High Recycling Programs	7	10
Energy Commission		
Full cost -effective natural gas efficiency improvements	1	6
Appliance Efficiency Standards [2]	3	5
Fuel-efficient Replacement Tires & Inflation Programs	3	3
Business Transportation and Housing		
Reduced Venting and Leaks in Oil and Gas Systems	1	1
State and Consumer Services		
Green Buildings Initiative	Not yet estimated	
Air Resources Board/CalEPA		
Hydrogen Vehicles	Not yet estimated	
Total Potential Emission Reductions [3]	**23**	**70**

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Comparison with Alternative Targets

	2010	2020
CEC estimated baseline emissions (very preliminary)* with adjustments** in 2020	538	575-590
2000 emissions (gross CA emissions w/imported electricity)	489	489
difference	49	86-101
1990 emissions (gross CA emissions w/imported electricity)	439	439
difference	98	136-151
CCAP/ICF measures	44	117
Strategies already underway in CA	23	70
Total mitigation measures	67	187
Hypothical additional reductions from power/refining (stabilize at 2000/current levels)	17	32

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Summary of Cost-Effectiveness of Measures Identified ($/MTCO$_2$e)

Cumulative GHG reductions from CCAP/ICF measures at each cost step, all sectors (approximate)		
Step	**Reductions (MMTCO2e)**	
	2010	**2020**
<0	7	10
<$10	22	25
<$20	27	31
<$30	29	38
<$50	29	63

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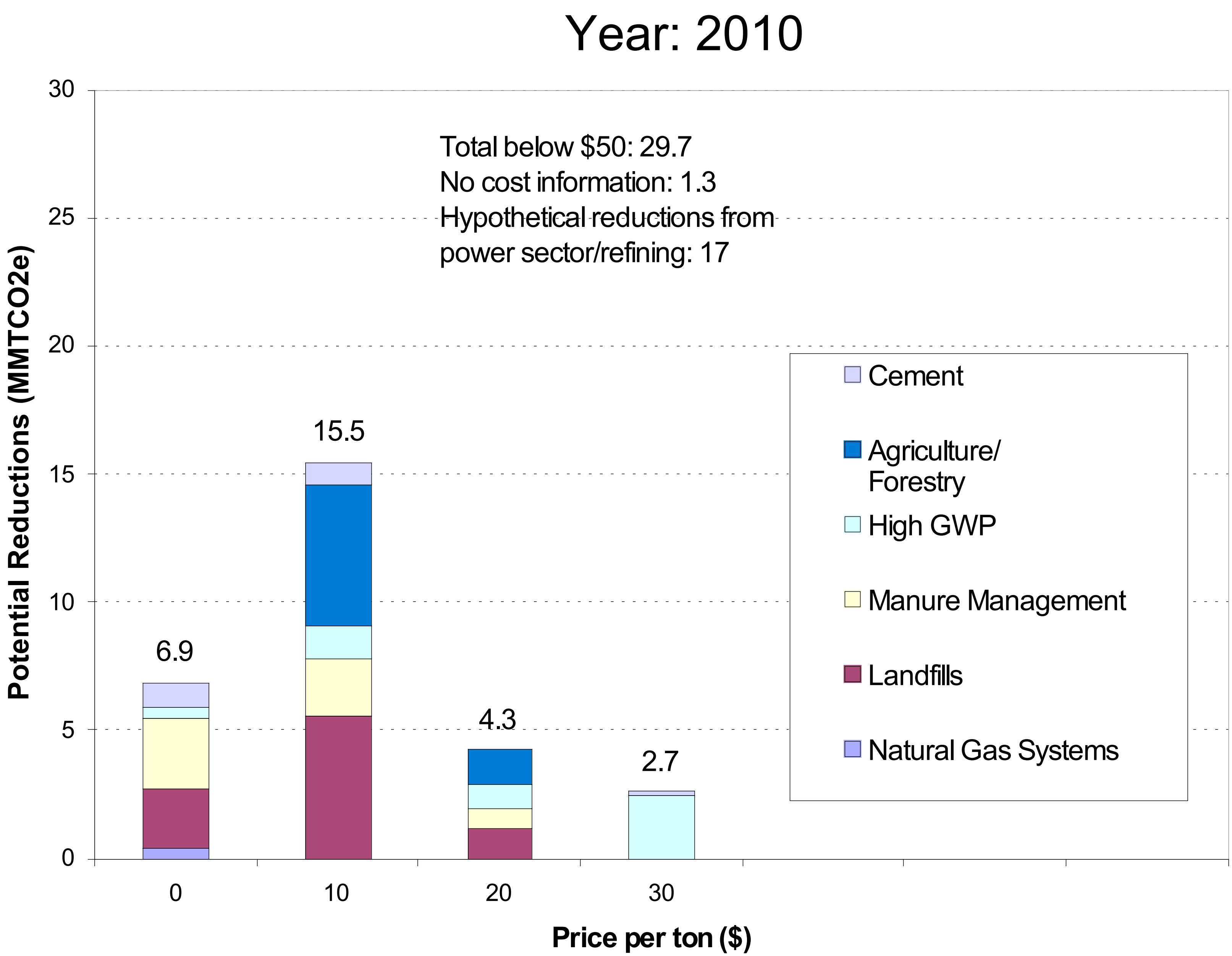
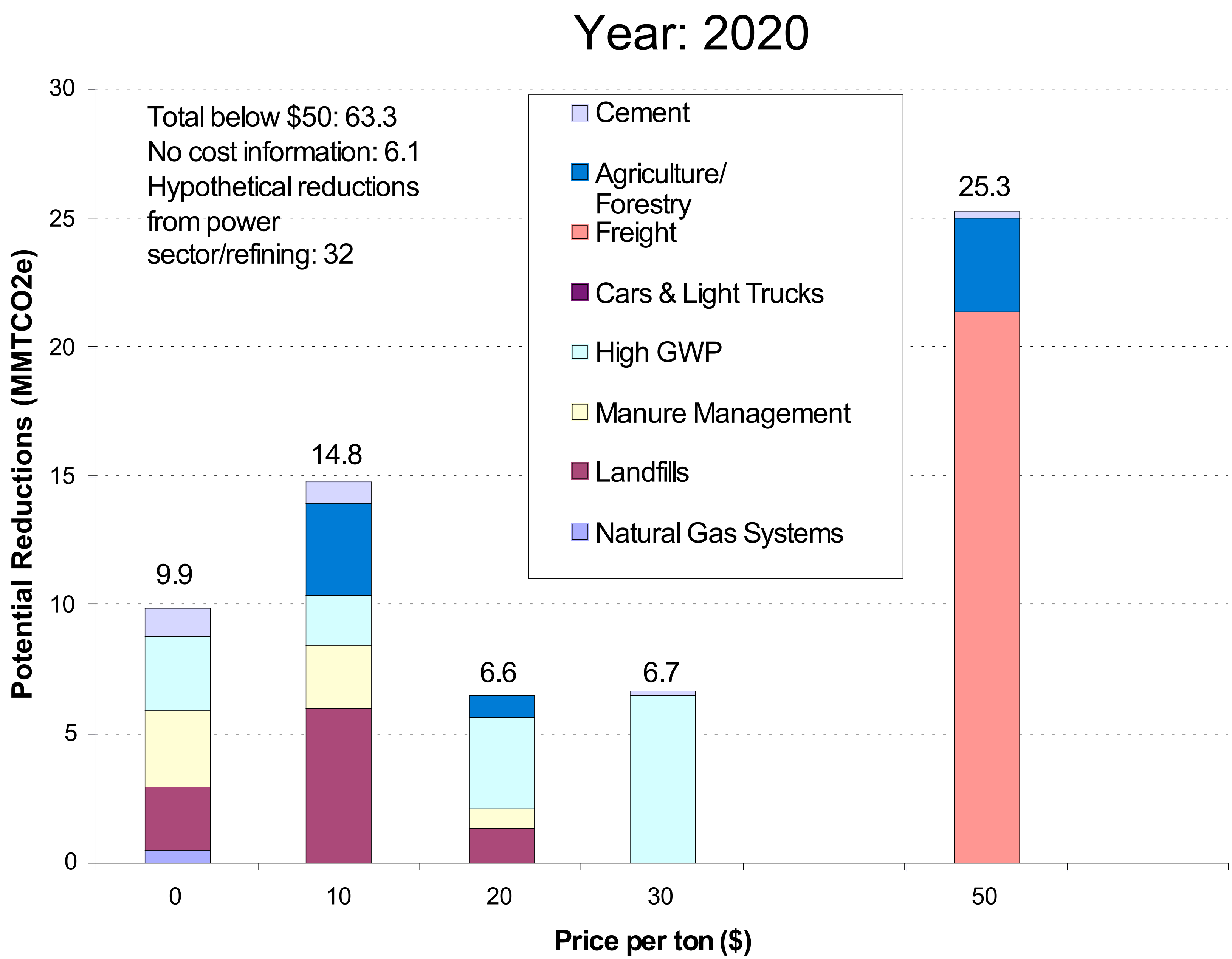


Year: 2010
Total below $50: 29.7
No cost information: 1.3
Hypothetical reductions from power sector/refining: 17
Potential Reductions (MMTCO2e)
30
25
20
15
10
5
0
6.9
15.5
4.3
2.7
Cement
Agriculture/ Forestry
High GWP
Manure Management
Landfills
Natural Gas Systems
0
10
20
30
Price per ton ($)



Year: 2020
Total below $50: 63.3
No cost information: 6.1
Hypothetical reductions
from power
sector/refining: 32
Cement
Agriculture/
Forestry
Freight
Cars & Light Trucks
High GWP
Manure Management
Landfills
Natural Gas Systems
9.9
14.8
6.6
6.7
25.3
30
25
20
15
10
5
0
Potential Reductions (MMTCO2e)
0
10
20
30
50
Price per ton ($)

Some Broad-Based Approaches to GHG Mitigation

Mandatory Approaches

- Technology-based
- Intensity standards and benchmarks
- Cap-and-trade
- Pollution fees
- Monitoring and reporting requirements

Voluntary Approaches

- Negotiated agreements
- Incentive programs
- Voluntary programs
- Education and assistance
- Removal of barriers to GHG reductions

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Technology-Based Approaches

- **Example policies:** Building codes, appliance standards, new source performance standards, new source review, ZEV/LEV programs
- **Advantages:**
  - Can mandate desired level of technical improvement from business-as-usual conditions
  - Usually applicable to an entire sector, resulting in broad-based participation in emissions reductions
- **Disadvantages:**
  - May not achieve desired reduction target depending on industry growth
  - May not achieve technological innovation because often based on known technologies
  - May encourage investment in the “wrong” technologies
  - May cost more than other mandatory programs due to lower levels of compliance flexibility

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Intensity Standards and Benchmarks

- **Example policies:** emissions limit per unit of production or GDP; limits on energy use per unit of production or GDP; car GHG standards
- **Advantages:**
  - Allows for growth in industrial production and less carbon intensive
  - Can set a benchmark to require existing facilities at a given level of output to do better than estimated business-as-usual conditions
  - Can be applicable to an entire sector, resulting in broad-based participation in emissions reductions
  - Compliance flexibility possible through trading w/in the benchmarked sector
- **Disadvantages:**
  - May not achieve desired reduction target depending on level of industry growth
  - Possible to trade with capped sectors as well, but more complicated

Cap-and-Trade

- **Example policies:** Acid Rain Trading Program, RECLAIM, EU ETS
- **Advantages:**
  - Achieves specific cap level (or below), on average, over the course of the program
  - Encourages the most cost-effective (cost/ton of emissions reduced) compliance options, can stimulate technological innovation
  - Can be applicable to an entire sector, resulting in broad-based participation in emissions reductions
- **Disadvantages:**
  - Not appropriate for all sectors (e.g., sectors with many small sources of emissions or that cannot get good data on emissions)
  - Uncertainty about total cost (unless includes a price cap as well)

Pollution Fees

- **Example policies:** Emission fees, raw materials taxes, energy taxes, product and excise taxes, toll roads
- **Advantages:**
  - Raises funds that can be used to support other climate policies and measures or reduce other taxes
  - Encourages reductions that cost less than the tax
  - Encourages the most cost-effective (cost/ton of emissions reduced) compliance options
- **Disadvantages:**
  - May not achieve desired reduction target
  - Often faces stiff political opposition

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Monitoring and Reporting Requirements

- **Example policies:** Toxics Release Inventory; Mandatory GHG Reporting in NJ; Motor Vehicle Inspection Programs; Product labeling
- **Advantages:**
  - » Assists with inventory development
  - » May encourage reductions from high emitters
  - » Informs consumers
  - » Provides data needed to support certain control approaches
- **Disadvantages:**
  - » Level of reduction likely to be uncertain

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Negotiated Agreements

- **Example policies:** NJ Silver/Gold Track; Netherlands Energy Efficiency Benchmarking
- **Advantages:**
  - » Targets are negotiated, providing some industry flexibility
  - » Compliance is mandatory. Failure to comply may result in loss of incentives or application of penalties.
- **Disadvantages:**
  - » Participants self-select; can lead to lowest common denominator targets, overall sector emissions could increase.
  - » Targets vary in stringency

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Incentive Programs

- **Example policies:** CA renewables reverse auction; Tax credits; Loan assistance, Direct government purchase of reductions (Netherlands & UK), offsets to cap & trade
- **Advantages:**
  - » Improves economics of emissions reductions, providing an incentive to change behavior
  - » Reverse auction & government purchase options provide certainty of achieving some reductions
- **Disadvantages:**
  - » Costs incurred by government and/or taxpayers can be large
  - » “free rider” problem – could be paying for “anyway” tons
  - » Hard to get sectors that begin as offset generators or recipients of payments to later accept regulation

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Voluntary Programs

- **Example policies:** California registry, EPA Climate leaders,
- **Advantages:**
  - » Allows for significant compliance flexibility
  - » Educates companies about issue and benefits of reductions
- **Disadvantages:**
  - » Participants self-select; because a large part of a sector may be excluded, overall sector emissions could increase.
  - » Targets may not be particularly aggressive
  - » No penalties for non-compliance, so reduced incentive to comply

Education and Assistance

- **Example policies:** Training; Consumer Education; Environmental audits
- **Advantages:**
  - » Helps overcome knowledge barriers
- **Disadvantages:**
  - » Hard to assess impact
  - » May not achieve desired reduction target

Removal of Barriers to GHG Reductions

- In some cases, removal of policy or market barriers to technology implementation may be needed to encourage desired behaviors or to achieve mandatory GHG reductions for a given sector at a reasonable cost (e.g. blended cement, net metering)
- Such changes should be evaluated against the original purpose of the particular policies in question.

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Sectors Covered in CCAP/ICF Analysis

- Transportation
- Sinks (forestry and agriculture)
- Cement
- Landfills
- Dairy/Manure Management
- Natural Gas
- Semiconductor

- We are still evaluating costs of measures for the power sector.
- A bottom-up assessment of options in refining will be difficult due to insufficient data on in-state facilities and the effectiveness of specific control measures.

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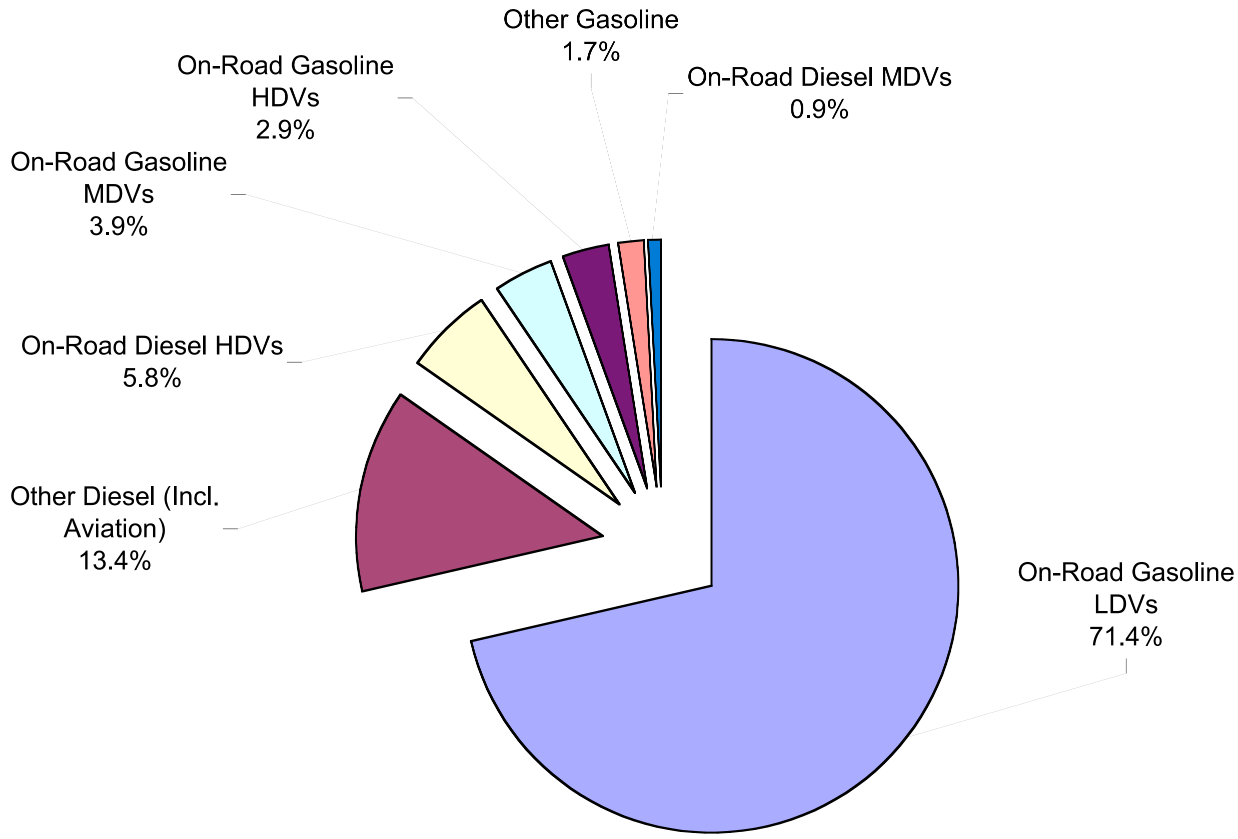
2002 CA Transportation GHG Emissions (by vehicle weight)



LDVs = Light Duty Vehicles (cars and trucks)
MDVs = Medium Duty Vehicles, cargo vans, delivery vehicles (up to 8500lbs GVW)
HDVs = Heavy Duty Vehicles, > 8500lbs
Source: California Energy Commission, 2004.

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Review of Transportation Measures

- Baseline annual CO_2 emissions increase from **190 $MMTCO_2$ in 2002** to **310 $MMTCO_2$ in 2020**
  - assumes 1.8% annual VMT growth
  - represents 41% of state GHGs (2002 CEC inventory)
- 2020 transport reductions = **65.4 $MMTCO_2$**.
- Pavley standards are projected to achieve **30 $MMTCO_2$** in 2020, ‘advanced’ Pavley could achieve more
- <u>Reductions from 3 core groupings</u>
  - Light duty vehicles (50% of savings)
  - Heavy duty vehicles & fuels (36% of savings)
  - Ports, aviation and rail (14% of savings)

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Summary of Transportation Sector GHG Reductions in California			
Program or Policy	**2010**	**2020**	**2020 $/MMTCO2e**
	(MMTC02e)	(MMTC02e)	(millions)
CARS & LIGHT TRUCKS			
Corn & Cellulosic Ethanol (vehicles using 85% ethanol)	0.33	11.51	$43
Reduction in vehicle miles traveled (VMT)	0.5	5.49	TBD
H2, Plug-in Hybrids, CNG & LPG Light Duty Vehicles (LDVs)	0.25	2.44	$331 - $1923
CA Feebate Program	TBD	TBD	TBD
Pay As You Drive Insurance	TBD	TBD	TBD
Subtotal	**1.1**	**19.4**	
FREIGHT TRANSPORTATION			
Diesel HDVs (CNG, Efficiency, Hybrids) & Gasoline Medium Duty Hybrids	2.63	24.85	$49 - $309
Biodiesel and Synthetic Diesel Alternatives	0.55	9.85	$51
Subtotal	**3.2**	**34.7**	
PORTS, AIR & RAIL			
Aircraft Modifications, Operations and Weight Reduction	2.95	5.89	$144
Freight Rail (10% shift from truck)	0.66	3.77	$530
Port Electrification (forklifts, refrig trailers), Cold Ironing	0.38	1.06	$63 - $1429
High Speed Rail	0.00	0.53	TBD
Subtotal	**4.0**	**11.3**	
Total MMTCO2 potential savings	***8.3***	***65.4***	
% above CA 1990 Transport Baseline (1990 = 168 MMTCO2)	***62.2%***	***31.5%***	
Net 2020 MMTCO $_2$ (BAU 310)	*302*	*245*	

Source: CCAP based on 2005 IEPR and CEC analysis: ADDENDUM TO: OPTIONS TO REDUCE PETROLEUM FUEL USE IN SUPPORT OF THE 2005 INTEGRATED ENERGY POLICY REPORT (May 2005).
MMTCO2e = Million Metric Tons of Carbon Dioxide Equivalent

Potential Next Steps for Analysis

- Ensure no double counting w/ Pavley
  - » Flex fuel vehicle, state fleet standards
  - » H_2 fuel cells, alternative ZEV compliance pathways
- Consider a GHG-based fuel standards program
  - » Review AQ implications for ethanol & biodiesel
- Potential options for further analysis
  - » Revise Passenger & Freight measures, as appropriate
  - » Also: advanced Pavley standards, Pay as You Drive Insurance, GHG-based feebates, fuel economy standards, VMT costs,
- Consider development of an integrated policy framework

Transportation Sector
Potential Policy Approaches

Key principles being discussed

- Link specific strategies to broader approaches. Bottom-up approaches that promote detailed solutions (e.g., truck-stop electrification)
- Complement standards w/ Incentives
- Coordinate climate strategies w/ other transportation goals (e.g., Air quality, petroleum dependence)
  - » state and local policies should support these goals
- Balance short and long-term strategies
  - » The need for immediate reductions is clear, however, deep cuts will require long-term, transformational strategies

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Transportation Sector
Promising Policy Approaches

Key Policies and Programs:

- **Mandatory Reductions.** Require cleaner fuels/fuel blends in all state fuel (e.g., Minnesota)
- **Provide Incentives** for purchase/use of efficient vehicles, travel patterns
  - » Examples: feebate program for light duty vehicles, funding for scrappage of older vehicles, accelerated turnover of older airplanes
- **Best Planning Practices.** Integrate climate reduction goals into transportation planning and freight planning
  - » Provide full or supplemental funding for MPO plans w/ climate-friendly measures (VMT reduction), infrastructure or design guidelines practices
  - » Examples: truck route optimization, expanding freight rail, electrification
    - – This is likely to be a long-term effort
- **Prioritize polices with multiple benefits.** Rank GHG measures based on multiple criteria (e.g., petroleum savings, criteria pollutant reductions)
  - » Example: ACEEE's Green Score

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Baseline Carbon Sequestration in CA

- Forests and soils achieved a net reduction of 9.5 MMTCO_2e in 1999 (*Inventory of California Greenhouse Gas Emissions and Sinks: 1990-1999*)*
- Carbon storage in wood products and landfilled waste increased 9.3 MMTCO_2e that year, accounting for the net reduction.
- Altogether, carbon sequestration offset 4% of total state emissions in 1999.

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* Note: Does not include sequestration from landfills and products. The 2002 sequestration estimate is slightly higher than in 1999.

Options for Add'l Forest and Agricultural Carbon Storage

- Sequestration
  - Afforestation
  - Thinning to promote growth and burying harvested wood
  - Converting hardwood stands to conifer
  - Extending timber harvest rotations
  - Enhancing yard trees
  - Increasing use of no-till cropping
- Reducing Emissions
  - Thinning to promote forest growth with energy from biomass (displacing fossil fuel emissions)
  - Reducing clearing of forest land

Activity	Number of Tons	Levelized Cost/Ton	Notes
Afforestation	3.5 MMTCO_2e per year, average over 80 years.	$6 to >$ 70 depending on land cost.	Few tons for 10 -20 years. Can reduce cost by thinning .
Forest health thins	3.7 MMTCO_2e per year, indefinitely.	<$10	
Landfill thinnings	9.5 MMTCO_2e per year, indefinitely.	$24 to $96	Cost depends on fiber pr ice.
Thin to Reduce Fire	None	Not Applicable	Appears to cause net emissions
Convert hardwood to conifer	Cumulative, 70 MMTCO_2e over 45+ years.	$10	No GHG benefit for 10-20 years
Extend rotations	0.7 MMTCO_2e per year for decades	$110-$140	No GHG benefit in first ten years
Reduce forest loss	0.9 MMTCO_2e per year for decades	< $20?	Implemented via development rules
Enhance yard trees	< 0.1 MMTCO_2e per year?	Uncertain	Also reduces cooling demand
Increase no -till	3.8 MMTCO_2e per year for 15 years	< $5 if b y education $100 if rental payments reqired	

Estimated Additional Sequestration from Evaluated Measures

- If these measures were all used, California could achieve an additional 12.5 MMTCO2e of carbon sequestration in 2010 and 18 MMTCO2e of carbon sequestration in 2020.
- At higher prices, substantially more tons of carbon might be sequestered
- Biologically, it is possible to achieve much more sequestration than estimated here but the total biological potential will not be achieved because:
  - Forest management will not be applied in reserves
  - Some locations are too far from roads or too steep to be treated
  - Risks to other values are too high at some locations, such as risks of erosion or damage to habitat of an endangered species

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Forestry Sector
Potential Policy Approaches (1)

- Require Specific Technologies or Practices
  - Could work for extending rotations
  - Less flexible than cap-and-trade and, unlike voluntary programs, could impose high costs on landowners.
- Cap-and-Trade
  - Design of the cap could be based on historic baseline years for individual lands or on historic baseline years for different vegetation/soil types.
  - Landowners would need to maintain carbon stocks at this level, or buy allowances if they go below the baseline. They could sell allowances if their stocks exceed their baseline.
  - Would only apply to larger ownerships
  - May be politically difficult to regulate the forestry sector, even if the chosen cap level does not require an increase in sequestration.

Forestry Sector
Potential Policy Approaches (2)

- Voluntary Project-Based Sequestration
  - Could be implemented via private or state purchase of offsets
    - Through **private purchases** of sequestration offsets, capped sectors could meet their caps more cost-effectively.
      - Policy could require some share of the reductions to be retired to enhance the likelihood that this sector would make an independent, additional contribution to the state target.
    - **State purchases** of sequestration offsets would ensure reductions are additional to other programs and would help meet overall state target. However, state funds would be needed to support these actions.
  - Establishing a baseline for each project is difficult.
  - State could streamline the baseline issue by setting standard baselines for different forest types, by region

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Numbers of Private Forest Landowners by Property Size, in California

Minimum Ownership Included (acres)	Number of Owners Included	Number of Acres Included	Percentage of Acres Included
10	143,078	13,288,968	91.8
50	46,656	11,624,228	80.3
100	21,773	9,901,584	68.4
500	2,419	6,528,676	45.1
1000	1,037	5,616,688	38.8

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Note: The Forest Service estimates there are 23 million acres of public forest land in California. Including public lands would significantly increase the scope of the program.

Agricultural Sinks
Potential Policy Approaches

- **Requiring specific technologies** would require substantial capital spending and learning by farmers
- A **cap-and-trade** program for soil carbon would require either: (a) state determination of effects of reducing tillage on various locations and soils, or (b) creation of substantial capacity to precisely measure soil carbon stock changes
- **Voluntary** project-based sequestration can work like forestry, with somewhat less difficulty setting baselines – may not be as attractive in CA as in Midwest because of different crops

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Landfills (1)

- Baseline emissions are projected to increase from 9.87 MMTCO2e in 2000 to 10.64 and 11.43 MMTCO2e in 2010 and 2020.
- Options evaluated include direct gas use projects (gas is collected and transported to an end user) and electricity projects (gas is collected and used to generate electricity) assuming different size landfills.
- Total reductions for this sector are estimated at 9.04 MMTCO2e in 2010 and 9.71 MMTCO2e in 2020.
- A total of 2.28 and 2.44 MMTCO2e are available in 2010 and 2020 for less than $0/MTCO2e; 7.81 and 8.39 MMTCO2e are available in 2010 and 2020 for less than $10/MTCO2e; and 9.04 and 9.71 MMTCO2e are available in 2010 and 2020 for less than $20/MTCO2e.
- Net impact (growth – redux) is slight increase in emissions above 2000

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Source: ICF Consulting, 2005

Landfills (2)

- For larger landfills, the number and amount of waste are known with reasonable certainty.
  - However, even at these sites, residual emissions not captured in the collection system may represent 25% of total emissions. There are little data on the fraction that oxidizes versus the fraction that is emitted as methane.
- Smaller landfills report on a voluntary basis, so the dataset may not be complete.
  - In particular, data on waste in place for older landfills may be uncertain. Factors affecting the rates of decomposition and the timing and amount of CH4 generation are very site-specific and data may not be adequate.
- These data gaps suggest a need for more systematic reporting.

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Source: Klein, D., June 2005

Landfills
Potential Policy Approaches

- Due to measurement difficulties for both large and small landfills, this source could **not** be easily included in an allowance-based **cap-and-trade** system. Other **mandatory** approaches (e.g., technology-based approaches) may be more viable.
- Where gas capture systems are in place, measurement of emissions reductions can be readily determined, making a **voluntary credit-based system** technically viable, though additionality issues would need to be resolved. Also, a voluntary program may not capture all or most of the emissions from this sector.
- A third approach is a **hybrid** allowance and credit-based system in which initial allowance requirements are based on gross emissions using indirect measures and adjusted for CH_4 captured pursuant to existing requirements. For smaller landfills, credits could be earned for gas collection and flaring, and additional credits could be awarded if beneficial use is made of the gas. For sources already reducing emissions, credits would be restricted to beneficial use of the gas.

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Dairy/Manure Management

- Baseline emissions are projected to increase from 7.82 MMTCO2e in 2000 to 8.85 and 9.54 MMTCO2e in 2010 and 2020.
- Options evaluated include covered lagoons and various kinds of digesters applied to different size dairy farms.
- Total reductions for this sector are estimated at 5.82 MMTCE in 2010 and 6.24 MMTCE in 2020.
- A total of 2.79 and 2.99 MMTCO2e are available for less than $0/MTCO2e in 2010 and 2020; 5.07 and 5.44 MMTCO2e are available for less than $10/MTCO2e in 2010 and 2020; and the remaining tons are all available for less than $20/MTCO2e.
- The majority of reductions come from covering lagoons and collecting the CH4 emissions for energy use.

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Source: ICF Consulting, 2005

Manure Management
Potential Policy Approaches (1)

- **Mandatory** control approaches might focus on larger farms or just on those with liquid management systems.
- **Technology-based approaches** are possible alone or coupled with incentives. Based on ICF's analysis, covered lagoons appear to be the lowest cost approach and have a high reduction potential. Biodigesters appear to be cost-effective, but these costs do not include added costs for NOx control (lean burn engines or SCR). There are also questions about whether SCR will be sufficiently effective to meet tight NOx control standards in the Valley or whether centralized facilities can get economies of scale on NOx control.
- A **cap** for this sector would likely be based on an estimated rate per animal given the difficulties of tracking actual emissions from animals. Because of baseline problems, it might be preferable to go with a credit or offsets approach for covering lagoons and use of digesters rather than a cap.

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Manure Management
Potential Policy Approaches (2)

- **Incentives** can lower the costs of mandatory control programs or provide incentives for greater participation in voluntary programs. Promising approaches include:
  - » Net metering and streamlined interconnection procedures
  - » Incentive payments to buy down capital costs or as a production tax credit
- **Voluntary approaches**, such as selling credits into a trading system, can also achieve reductions. Sharing the credits between the atmosphere and buyers could ensure a contribution to achieving an overall state target by this sector.
- **Technology demonstration** and development of **standardized technology** may also be helpful, in conjunction with a mandatory or voluntary program.

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Semiconductor

- Baseline emissions are projected to increase from 1.03 MMTCO2e in 2000 to 3.36 and 7.74 MMTCO2e in 2010 and 2020 (California-specific estimates under development).
- Options evaluated include plasma abatement, remote clean, catalytic abatement, capture/recovery and thermal destruction.
- Total reductions for this sector are estimated at 3.10 MMTCE in 2010 and 7.14 MMTCE in 2020 and costs range from $12 to 30/MMTCO2e..
- The lowest cost measure ($12.86/MTCO2e), plasma abatement, reduces 0.72 MMTCO2e in 2010 and 1.65 MMTCO2e in 2020.
- One measure, remote clean, achieves over half the total reductions (1.64 MMTCO2e in 2010; 3.76 MMTCO2e in 2020).
- These reductions are roughly equal to the national commitment by the semiconductor industry to reduce emissions to 10% below 1995 levels

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Source: ICF Consulting, 2005

Semiconductor Industry
Potential Policy Approaches

- Sector has national and international commitments to reduce emissions to 10% below 1995 levels by 2010.
- A similar voluntary commitment or mandatory requirement could be established in California.
- Alternatively, this voluntary target could be linked to a state trading system by allowing the sector to sell allowances if it does better than its voluntary target, but not be penalized if it does worse.

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Update on Power Sector Analysis

- Power sector is second largest source of GHG emissions in CA totalling 95.2 million tons of CO_2 in 2002 inventory w/ 51.7 coming from imports
- Purpose of the analysis is to assess the costs of various policy options including expanded energy efficiency, accelerated RPS, and various cap levels alone or in combination
- Focus will be on a cap on load-serving entities in California approach as way to assess potential of CA policy impact on electricity imports

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Update on Power Sector Analysis

- NEMS model will replicate current transmission links and constraints between CA and other WECC states, will also model 2 markets for power, one w/ carbon constraint (CA) and one without (rest of WECC)
- The Power Sector Workgroup has been developing assumptions for use, an initial reference case was developed and assumptions are being refined
- Coding changes have been made to allow analysis of caps on emissions associated with power demand.
- The Power Sector Workgroup of the CCAC is meeting tomorrow to review modeling assumptions.

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Petroleum Refining
Potential Policy Approaches (1)

- Baseline emissions in CA from this sector are substantial – 35 million tons in 2002
- Mandatory emissions control could be achieved in several ways.
  - » **Technology-based approaches** would require very detailed information on the sector.
  - » This sector could also be **capped** as part of an upstream or downstream trading program. An **upstream** program has advantages such as comprehensive coverage and low administrative costs, however, it relies on price signals and may function like quotas on fuels production.
  - » Establishment of emissions **benchmarks** (emissions/unit output) based on top performing plants.

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Petroleum Refining
Potential Policy Approaches (2)

- Key issues in designing a petroleum refining policy are 1) **lack of emissions data** by process; and 2) **lack of cost estimates for potential reductions**.
- **Mandatory emissions reporting** can help overcome data limitations and would be needed to support development of a mandatory control approach. Current **voluntary reporting** has had very limited participation from this sector.
- Data exists for refinery-wide emissions so cap could be set for each refinery based on this. A price cap could be set to limit risk of unacceptably high costs.

Petroleum Refining
Potential Policy Approaches (4)

- **Incentives** and **voluntary approaches** – other issues to evaluate:
  - » Do barriers to new refinery capacity affect production efficiency? If so, would it be desirable to consider overcoming these barriers?
  - » Incentives to encourage advanced technology and practices, such as use of non-virgin, captured carbon in enhanced oil recovery.
  - » What would be the impact on refinery emissions of encouraging biofuels to be produced at a refinery? (Federal tax benefits currently are only available to ag producers.)

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Update on Refining Analysis

- CCAP determined that data were insufficient to develop a reliable emissions baseline by process within a refinery or to assess specific mitigation measures and costs for this sector.
- We are consulting with industry on process and policy options for overcoming data gaps and for achieving emissions reductions from this sector.

Baseline Cement Emissions in CA

- Baseline annual <u>direct</u> CO_2 emissions to increase from 10.4 to 15.1 $MMTCO_2$ from 2005 to 2025 (assuming 2% annual sector growth).
- Cumulative cement emissions during that time period are estimated at 263 MMTCO2.
- Baseline emissions are projected to be 11.3 MMTCO2 in 2010 and 13.6 MMTCO2 in 2020.
- 1% sector growth lowers the baseline by ~12% relative to the 2% growth scenario

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Most Cement Reductions from 3 Measures

- 70% of cumulative emissions reductions from 2 measures
  - Limestone Portland Cement: 12.6 MMTCO_2 at ($21)/MT (savings)
  - Blended Cement: 14.0 MMTCO_2 at $2.40/MT
- Possible 3.6-MMTCO_2 reduction from Waste Tire Fuel at ($14)/MT (savings), but dependent upon current waste-tire use
- All 3 measures have market barriers to implementation
  - Limestone Portland Cement: Market acceptance
  - Blended Cement: Cement standards
  - Waste Tire Fuel: Public resistance
- State policies need to address these market barriers to enable emissions reductions from CA cement sector

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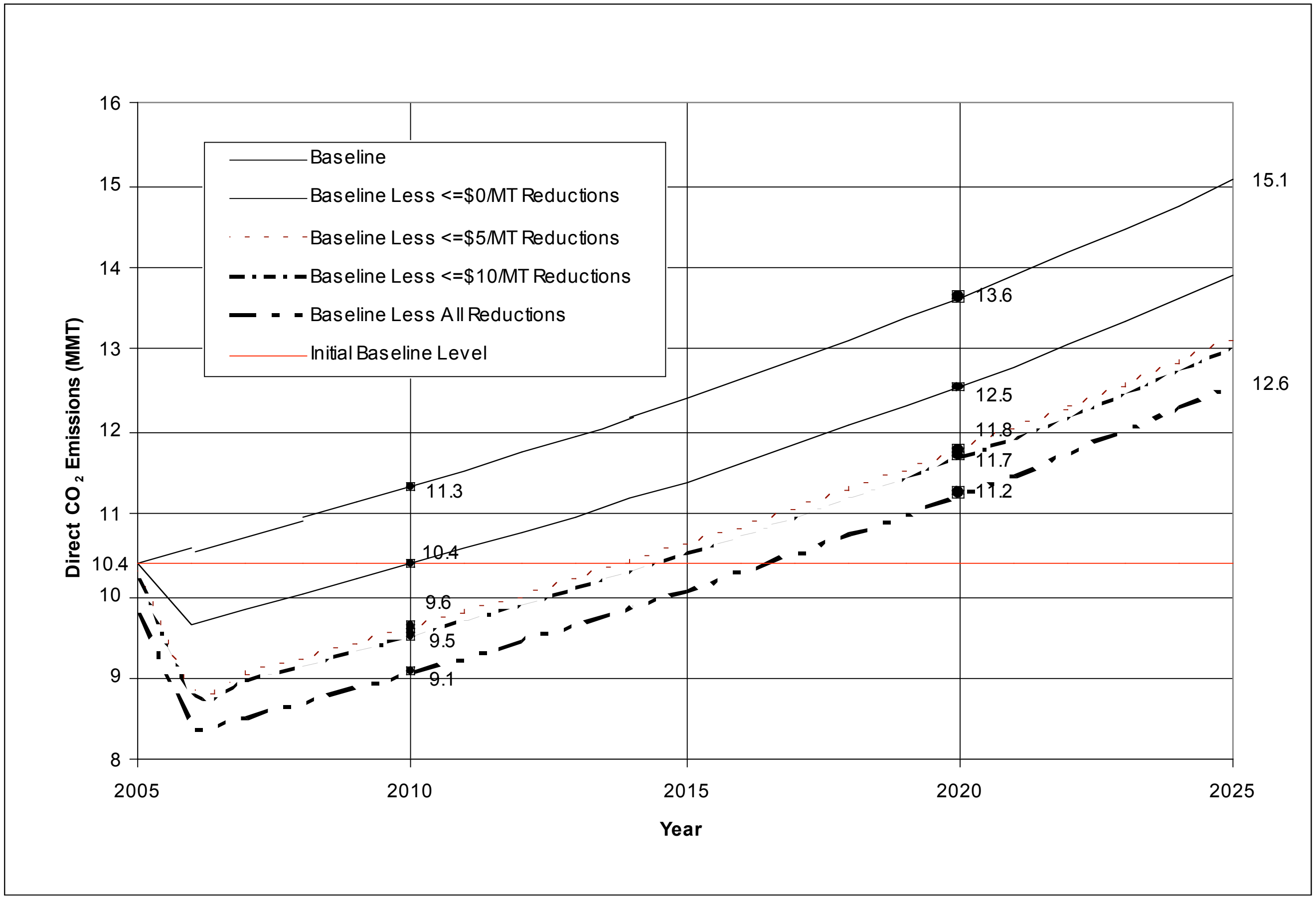
Projected Future Direct Emissions from CA Cement Sector (2% Annual Sector Growth)



At best, annual emissions return to initial value by 2017 and exceed it by 2.2 MMTCO2 in 2025, reaching 12.6 MMTCO2

Cement Sector
Potential Policy Approaches (1)

- **Requiring specific technologies** may be less effective in cement due to significant technological variations across facilities.
- Emissions **benchmarking** per unit of output (i.e., clinker, cement, or both) could achieve reductions from this sector but would not guarantee a decrease in emissions.
- The cement industry may be well-suited to **cap-and-trade** given the relatively small number of plants. However, additional research is needed to understand the degree to which leakage would occur and whether or not any leakage is likely to result in a net increase in emissions. Border adjustments are a possible remedy if leakage is believed to have adverse effects, though such adjustments are difficult to implement.
- Existing **voluntary** national industry commitments could be made binding at the state level, or the sector could be treated as an offset. However, such treatments may not achieve the desired emissions reductions from this sector in California.

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Cement Sector
Potential Policy Approaches (2)

- Under either a mandatory or voluntary control approach, the following measures are needed to **overcome barriers** to emissions reductions:
  - » For limestone Portland cement and blended cement, the state should codify their use in public-works projects, and encourage it in the private sector.
  - » For waste tires as fuel, the state should take a more active role in explaining the benefits of their use (reduced CO_2 emissions due to reduced coal consumption, reduced air pollution from open tire burning, reduced mosquito vectors) to the public.
  - » Also to encourage waste tires as fuel, the state should demonstrate to the public that kiln combustion of waste tires results in the cited environmental benefits.

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Natural Gas

- Baseline emissions are projected to increase from 1.81 MMTCO2e in 2000 to 2.00 and 2.19 MMTCO2e in 2010 and 2020.
- 22 separate options were evaluated. When ordered from low to high cost, no one measure reduces emissions by more than 5% of the baseline.
- Total reductions for this sector are estimated at 0.725 MMTCO2e in 2010 and 0.795 MMTCO2e in 2020.
- A total of 0.466 and 0.392 MMTCO2e are available for less than $0/MTCO2e in 2010 and 2020; 0.505 and 0.554 MMTCO2e are available for less than $20/MTCO2e; while additional reductions are more costly

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Source: ICF Consulting, 2005

Natural Gas Systems
Potential Policy Approaches (1)

- The extensive scope of the natural gas system in the US poses a substantial challenge for administering broad-based **mandatory** control programs. Moreover, on a per-component basis, emissions are small.
  - » For example, EPA's national estimate of 33.2 $MMTCO_2e$ results from a natural gas distribution system that spans a network of 1.5 million miles of distribution pipeline and over 40 million customer meters. Leaks are small but numerous, irregularly distributed, and difficult to track and measure.
- Compressor stations, a subsector of the natural gas system, may be more easily included in a **mandatory** control program because they are relatively significant, small in number, and easy to measure. However, further improvements may be needed in the accuracy and efficiency of leak detection.
- Use of a **voluntary** credit-based approach alone would result in a lack of coverage.

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Natural Gas Systems
Potential Policy Approaches (2)

- A third option is a **hybrid** approach, combining an allowance based system using indirect methods and activity factors in conjunction with volumes of gas at a facility or distribution stage, with a credit-based system.
- Another approach is to **increase the emissions factor** used to calculate CO_2 emissions from the combustion of natural gas for downstream fuel users from 117 lbs. CO_2/MMBtu to about 125 or 126 lbs. CO_2/MMBtu. To ensure there are also incentives to make reductions upstream, this emission factor increase could be **combined with a voluntary credit-based approach**.

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Conclusions

- Emissions reductions from multiple sectors are needed to meet emission reduction goals at 2000 or 1990 levels.
- Assuming reductions from the power and refining sectors, the State could meet its targets by focusing on measures that cost less than \$10-20/MTCO$_2$e in 2010 while options could be more costly to meet the target in 2020.
- Further in-depth analysis of options would produce a more complete picture and technological innovation could lower costs significantly
- Some options currently face technical or policy barriers to implementation as well as political hurdles that could prevent full penetration of the lowest cost approaches.

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Conclusions (2)

- Broad-based participation and use of mandatory control approaches will increase the likelihood of meeting an emissions target.
- Some mandatory and voluntary approaches (or hybrids) are better suited to some sectors than others, both technically and politically.
- There is no "silver bullet" either in terms of inexpensive reduction opportunities or "one size fits all" measures. State strategy will need to combine different tailored approaches to each sector to create synergies and reduce industry resistance.

For Further Information

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